

1,185,199



# PATENT SPECIFICATION

DRAWINGS ATTACHED

1,185,199

Inventor: SEBASTIAN VINCENT NICASTRO.

Date of Application (No. 15937/67) and filing Complete Specification: 6 April, 1967.

Complete Specification Published: 25 March, 1970.

Index at Acceptance:—A5 T (1, 4C2); F4 P (1A2, 1B4, 1B6, 1C, 1X, 12).

International Classification:—A 62 b 21/00.

## COMPLETE SPECIFICATION

### Breathing pack for converting liquid air or oxygen into breathing gas

SPECIFICATION NO. 1,185,199

By a direction given under Section 17 (1) of the Patents Act 1949 this application proceeded in the name of THE ARO CORPORATION, a Corporation organised under the laws of the State of Delaware, United States of America of 400 Enterprise Street, Bryan, Ohio 43508, United States of America.

THE PATENT OFFICE

R 124011/1

form for breathing use and more particularly for use in work, such as emergency or rescue work, or in mines, where in use the apparatus, usually a portable pack, is shifted and held in various positions with reference to its normal vertical position, such as when carried on the back of a miner crawling up a slope in the mine.

One aim of this invention is to pressurize the liquid air or oxygen in the supply container by gas developed from the container liquid, by taking advantage of the high ratio of expansion of the liquid to gas, which in the case of liquid air is 630 to 1. Another aim of the invention is to prevent the returned gas from being recondensed into the liquid thereby to destroy its pressurizing effect and impair the expulsion of the liquid for breathing purposes. A further aim of this invention is to expel a large total amount of the liquid regardless of the angular position of the container between its normal upright position and its horizontal position, so as to render available for breathing purposes the largest practicable amount of the liquid.

Accordingly this invention provides apparatus for converting liquid air or liquid oxygen into gaseous form, which apparatus comprises (1) a liquid air or liquid oxygen container having a liquid outlet member and

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positions of the container between its normal upright position and its horizontal position, the gas inlet member is adapted to discharge gas into a space above liquid air or liquid oxygen in the container and thereby avoid recondensing the gas in the liquid air or liquid oxygen, and the liquid outlet member is adapted to expel the maximum total quantity of the liquid air or liquid oxygen in the container.

The apparatus of the invention may have a liquid outlet conduit communicating with the liquid outlet member, means for converting a part of the liquid air or liquid oxygen in the liquid outlet conduit into gas for breathing purposes, a gas pressurizing conduit communicating with the gas inlet member, means for converting a part of the liquid air or liquid oxygen in the liquid outlet conduit into gas and conducting such gas to the gas pressurizing conduit, and means actuated by gravity to move the liquid outlet to its lowest point and the inlet to its highest point within the container when the container is in angular positions between its normal upright position and its horizontal position. The gravity actuated means may be a weight fixed to the liquid outlet member.

A preferred arrangement is one in which

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## COMPLETE SPECIFICATION

### Breathing pack for converting liquid air or oxygen into breathing gas

We, THE FIREWELL COMPANY, INC., a corporation organised under the laws of the State of Ohio, located at 3695 Broadway, Buffalo, New York, United States of America, do hereby declare the invention for which we pray that a patent may be granted to us, and the method by which it is to be performed to be particularly described in and by the following statement:—

This invention relates to apparatus for converting liquid air or oxygen into gaseous form for breathing use and more particularly for use in work, such as emergency or rescue work, or in mines, where in use the apparatus, usually a portable pack, is shifted and held in various positions with reference to its normal vertical position, such as when carried on the back of a miner crawling up a slope in the mine.

One aim of this invention is to pressurize the liquid air or oxygen in the supply container by gas developed from the container liquid, by taking advantage of the high ratio of expansion of the liquid to gas, which in the case of liquid air is 630 to 1. Another aim of the invention is to prevent the returned gas from being recondensed into the liquid thereby to destroy its pressurizing effect and impair the expulsion of the liquid for breathing purposes. A further aim of this invention is to expel a large total amount of the liquid regardless of the angular position of the container between its normal upright position and its horizontal position, so as to render available for breathing purposes the largest practicable amount of the liquid.

Accordingly this invention provides apparatus for converting liquid air or liquid oxygen into gaseous form, which apparatus comprises (1) a liquid air or liquid oxygen container having a liquid outlet member and

a gas inlet member connected together and so arranged that, no matter how the container is oriented between its normal upright position and its horizontal position, the liquid outlet is always at the lowest point of the container and the gas inlet is always at the highest point, and (2) means for converting liquid air or liquid oxygen withdrawn from the container into gas and returning part of the gas to the container through the gas inlet member, the arrangement of the liquid outlet member and the gas inlet member being such that in angular positions of the container between its normal upright position and its horizontal position, the gas inlet member is adapted to discharge gas into a space above liquid air or liquid oxygen in the container and thereby avoid recondensing the gas in the liquid air or liquid oxygen, and the liquid outlet member is adapted to expel the maximum total quantity of the liquid air or liquid oxygen in the container.

The apparatus of the invention may have a liquid outlet conduit communicating with the liquid outlet member, means for converting a part of the liquid air or liquid oxygen in the liquid outlet conduit into gas for breathing purposes, a gas pressurizing conduit communicating with the gas inlet member, means for converting a part of the liquid air or liquid oxygen in the liquid outlet conduit into gas and conducting such gas to the gas pressurizing conduit, and means actuated by gravity to move the liquid outlet to its lowest point and the inlet to its highest point within the container when the container is in angular positions between its normal upright position and its horizontal position. The gravity actuated means may be a weight fixed to the liquid outlet member.

A preferred arrangement is one in which

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the liquid outlet member projects radially from a swivel journaled on the bottom of the container; in which the gas inlet member projects radially from a swivel journaled on the top of the container; and in which there is means connecting the swivels to compel them to rotate in unison. The swivels may be concentric and a rod may be fixed at its opposite ends to the swivels to compel them to rotate in unison. The opposing necks may be provided on the swivels concentric with their axis of rotation and the rod may then be in the form of a thin-walled hollow tube with its opposite ends embracing and fixed to the necks.

Apparatus in accordance with the invention in the form of a portable pack is simple and extremely reliable in operation and is not subject to breakdown or malfunction.

So that the invention will be better understood an example in accordance with it will now be described with reference to the accompanying drawings in which:

Figure 1 is a schematic representation of a breathing pack embodying the present invention;

Figure 2 is an enlarged central longitudinal section through a container for the liquid air or oxygen included in the breathing pack.

The invention is essentially concerned with the mechanism contained within a double walled container or bottle indicated generally at 5 and containing a body 6 of liquid air or liquid oxygen for breathing purposes. This container is included in a portable pack designed generally by the dot-dash line 8 and which can be strapped to the back of the miner or other user. A gas head 9, derived from the liquid 6 as hereinafter described, is used to pressurize the bottle 5.

The liquid air or oxygen 6 is withdrawn from the container or bottle 5 through a liquid outlet conduit 12 which has a branch 13 containing a fill valve 14 and having a filling connection indicated generally at 15. The liquid air or oxygen from the liquid outlet conduit 12 is converted into gas for breathing purposes by passage through a heat exchanger or heater 16 and the outlet line 18 which connects with a fitting 19 forming part of a quick disconnect indicated generally at 20. The other part 21 of this quick disconnect has a flexible line 22 leading to a face mask (not shown) of the miner or other user.

In the practice of the present invention a part of the liquid air or oxygen from the liquid outlet conduit 127 is converted into gas and this gas is used to pressurize the double walled container or bottle 5 by being admitted into the gas head 9 above the body 6 of liquid in the double walled con-

tainer or bottle 5. To this end a branch line or pipe 25 from the liquid outlet conduit 12 connects with the inlet of a build-up heating coil 26, the outlet line 28 of which contains a valve 29 and connects with the inlet of a pressure regulating valve indicated at 30. This pressure regulating valve has a relief valve 31 discharging into the atmosphere and its outlet line 32 connects with a gas pressurizing conduit 33 having a vent valve 34 and leading to the gas head 9 in the top of the double walled container or bottle 5. Desirably the breathing pack also includes a restrictor 35 in the liquid outlet conduit 12 between the branch line 25 and the heat exchanger 16; an accumulator tank 36 followed by a supply valve 37 in the line 18; a check valve 38 in the branch line 25 in advance of the build-up coil 26 and a relief valve 39 in the line 28 following this build-up coil 26.

The double walled container or bottle 5 is preferably of cylindrical form with its axis normally arranged upright and includes an inner cylindrical shell 40 having an upper end 41 and a lower end 42 and a concentric outer cylindrical shell 43 having an upper end 44 and a lower end 45. The space 46 between these shells can contain insulation (not shown). This insulation is preferably a pure vacuum or in the form of super-insulation, that is, alternate layers of porous paper and reflective foil.

To withdraw the liquid air or oxygen from the bottom of the double walled container or bottle 5, the liquid outlet conduit 12 connects with a fitting 48 extending through and secured, as by welding, to the lower end 45 of the outer shell 43 and connected by a pipe 49 in the space 46 with a fitting 50 extending concentrically through the lower end 42 of the inner shell 40. This fitting 50 has a bore 51 extending downward from the top of the fitting concentric with the axis of the inner container 40 and communicating at its lower end with the outlet pipe 49 leading to the liquid outlet conduit 12. An important feature of the invention resides in the bore 51 of the fitting 50 serving as bearing for a swivel 52. This swivel has a depending stem 53 journaled in the bearing bore 51 and has a vertical bore 54 extending upwardly from its bottom. The upper end of this bore 54 communicates with a liquid outlet tube 55 secured to and extending laterally outwardly from the swivel 52 and having its outer open end 56 arranged close to the juncture of the side wall of the shell 40 and its bottom end 42. The outer end 56 of this tube 55 also carries a weight 57 for a purpose which will presently appear.

The swivel 52 has an upstanding concentric neck 58 secured as by a pin 59, to a thin walled tube 60. This tube is

arranged concentrically of the inner shell 40 and its upper end is secured, as by a pin 61, to the depending neck 62 of a swivel 63. This swivel 63 has an upstanding neck 64 which is journaled in the open lower end of a bore 65 of a fitting 66 extending concentrically through and secured, as by welding, to the upper end 41 of the inner shell 40. The swivel 63 has a bore 68 which is open at its upper end and at its lower end communicates with a gas pressurizing tube 69 fixed to and extending laterally outwardly from the swivel 63. The open outward end 70 of the gas pressurizing tube 69 is arranged to swing close to the line of juncture of the side wall of the inner shell 40 and its upper end 41 and an important feature of the invention resides in the open ended gas pressurizing tube 69 projecting in the opposite direction with relation to the open ended liquid outlet tube 55, that is, these two tubes being 180° out of phase with reference to each other.

The upper end of the bore 65 is connected by a pipe 71 contained within the space 46 to a fitting 72 extending through and secured to the upper end 44 of the outer shell 43. This fitting 72 connects with the gas pressurizing conduit 33.

In use, in response to the inhalation demand of the user as applied at the quick disconnect 20, liquid air or oxygen is supplied to him, this liquid air or oxygen being supplied from the body 6 contained within the inner shell 40 of the double walled container 5 and flowing out the inlet end 56 of the weighted liquid outlet tube 55 into the bore 54 of the swivel 52. From this bore the required liquid air or oxygen flows into the bore 51 of the fitting 50 and thence through the pipe 49 and fitting 48 into the liquid outlet conduit 12 of the breathing pack. In the heat exchanger or heater 16 this liquid air or oxygen is converted into gaseous form before being supplied to the quick disconnect and to the breathing mask (not shown) of the user.

A part of this liquid air or oxygen from the liquid outlet conduit 12 enters the build-up heating control and is converted into gas, the pressure of this gas being under control of the pressure regulating valve 30 and its relief valve 31. From the outlet 32 of this pressure regulating valve 30 this gas enters the gas pressurizing conduit 33 and through the fitting 72, pipe 71 and fitting 66 enters the bore 65 of this last fitting and enters the bore 68 of the swivel 63 journaled in this bore 65. From the swivel 63, the gas enters the gas pressurizing tube 69 and its pressure is impressed against the gas head 9 in the inner shell 40 above the body 6 of liquid air or oxygen contained therein.

Since the swivels 63 and 52 are connected together by the concentric tube 60, as the

outer weighted end 56 of the liquid outlet tube 55 seeks the lowest position, through the tube 60, it swings the outer end 70 of the gas pressurizing tube 69 to the highest position within the inner shell 40. As a result, the incoming gas from the gas pressurizing tube 69 employed to pressurize the gas head 9 is admitted directly into this gas head because the outer end 70 of this gas pressurizing tube seeks the highest elevation which is also sought, of course, by the gas head 9. This is an important feature of the invention since if the incoming gas were introduced into the body 6 of liquid air or oxygen, it could recondense into liquid form and fail to provide the necessary pressure within the inner shell 40. There is a 630 to 1 expansion of liquid air into gas form, this being the basis for pressurizing the liquid body 6 to provide a uniform and steady pressure to expel the liquid air or oxygen.

As a further advantageous feature of the invention, the seeking of the lowest level within the inner shell 40 of the outer weighted end 56 of the liquid outlet tube 55 also insures the discharge of a large amount of liquid air or oxygen regardless of the position of the container or bottle 5 between its normal upright position and its horizontal position.

It will be seen that the invention is particularly applicable for air packs to be used by miners or other workers who are required to work in other than upright body positions, as when a miner is required to crawl along a slope in the mine. Thus, when this occurs, the axis of the double walled container 5 is brought to an angular position with reference to the vertical. When this occurs, the weight 57 at the outer end 56 of the liquid outlet tube 55 swings this outer end to the lowest position within the inner shell 40 so that even if only a small amount of liquid air or oxygen 6 is left within this inner shell, it will be supplied to the miner in response to his demands. More important, if the inner shell 40 at this time contains the maximum amount of liquid air or oxygen 6 with a minimum gas head 9 thereabove, this swinging of the weighted liquid outlet tube 55, through the tube 60 connecting the two swivels 52 and 63, swings the outer end 70 of the gas pressurizing tube 69 to the highest position with the inner container 40 so that it discharges directly into the gas head 9 and not into the body 6 of liquid air or oxygen to recondense therein and fail in its function of pressurizing this body 6 of liquid air or oxygen for use by the miner.

When the container or bottle 5 is tilted downwardly beyond its horizontal position, the outer end 70 of the gas pressurizing tube 69 will continue to discharge directly into the

gas head 9 until such time as the end 70 becomes immersed in the liquid air or oxygen. Obviously, the point at which the end 70 becomes immersed in the liquid air or oxygen depends on the amount of liquid air or oxygen in the container and on the precise shape of the container.

WHAT WE CLAIM IS:—

- 10 1. Apparatus for converting liquid air or liquid oxygen into gaseous form, which apparatus comprises (1) a liquid air or liquid oxygen container having a liquid outlet member and a gas inlet member connected together and so arranged that, no matter how the container is oriented between its normal upright position and its horizontal position, the liquid outlet is always at the lowest point of the container and the gas inlet is always at the highest point, and
- 15 (2) means for converting liquid air or liquid oxygen withdrawn from the container into gas and returning part of the gas to the container through the gas inlet member, the arrangement of the liquid outlet member and the gas inlet member being such that
- 20 in angular positions of the container between its normal upright position and its horizontal position, the gas inlet member is adapted to discharge gas into a space above liquid air or liquid oxygen in the container and thereby avoid recondensing the gas in the liquid air or liquid oxygen, and
- 25 the liquid outlet member is adapted to expel the maximum total quantity of the liquid air or liquid oxygen in the container.

2. Apparatus according to claim 1 including a liquid outlet conduit communicating with the liquid outlet member, means
- 30 for converting a part of the liquid air or liquid oxygen in the liquid outlet conduit into gas for breathing purposes, a gas pressurizing conduit communicating with the gas

inlet member, means for converting a part of the liquid air or liquid oxygen in the liquid outlet conduit into gas and conducting such gas to the gas pressurizing conduit, and means actuated by gravity to move the liquid outlet to its lowest point and the gas inlet to its highest point within the container when the container is in angular positions between its normal upright position and its horizontal position.

3. Apparatus according to claim 2 in which the gravity actuated means is a weight fixed to the liquid outlet member.

4. Apparatus according to claim 2 or claim 3 in which the liquid outlet member projects radially from a swivel journalled on the bottom of the container; in which the gas inlet member projects radially from a swivel journalled on the top of the container; and in which there is means connecting the swivels to compel them to rotate in unison.

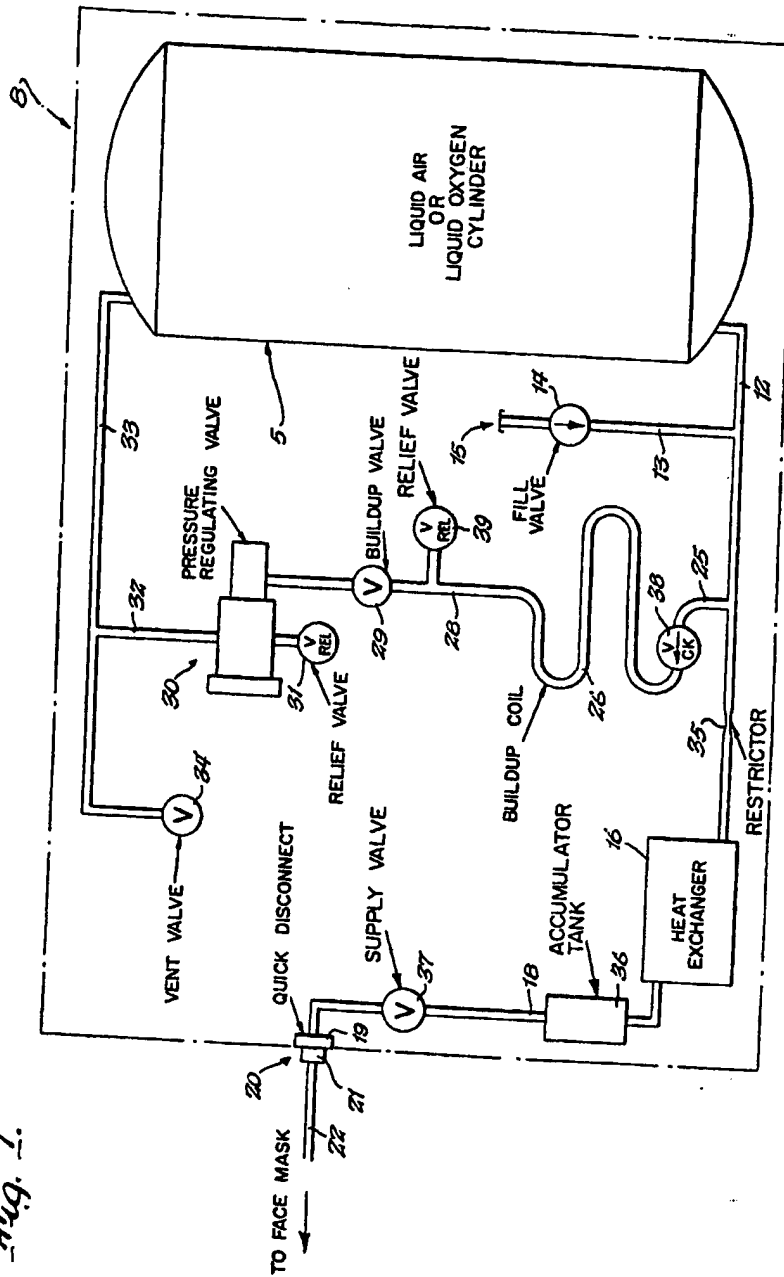
5. Apparatus according to claim 4 in which the swivels are concentric and a rod is fixed at its opposite ends to the swivels to compel them to rotate in unison.

6. Apparatus according to claim 5 in which opposing necks are provided on the swivels concentric with their axis of rotation and in which the rod is in the form of a thin-walled hollow tube with its opposite ends embracing and fixed to the necks.

7. Apparatus according to claim 1 substantially as herein described with reference to the accompanying drawings.

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Fig. 1.



1,185,199

2 SHEETS

COMPLETE SPECIFICATION

This drawing is a reproduction of  
the Original on a reduced scale.

SHEET 2

Fig. 2.

